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ABSTRACT

The Institute in Physical Science was developed to address the need for updated information and training in physics, chemistry, and technology among elementary and secondary teachers of physical science. Four major objectives were addressed: (1) improve teachers' understanding of fundamental concepts in physics and chemistry; (2) improve fifth- and sixth-grade teachers' understanding of physical science and provide them with training in the use of physical science activities and investigations and the essential elements to teach physical science in grades five and six; (3) provide high school physical science teachers with training in the use of activities and investigations stressing the development of the essential elements when teaching introductory physics and chemistry concepts; and (4) update teachers' knowledge of recent research findings in physics, chemistry, and science education. This report includes a description of the operation of the project and an evaluation of its effectiveness. Fifty-eight teachers participated in four courses: Concepts in Chemistry; Concepts in Physics; Frontiers in Physical Science; and Concepts in Physical Science. Program evaluation data show the participants reported to have achieved, in their opinion, each of its four objectives. (MVL)

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INSTITUTE IN PHYSICAL SCIENCE

A Category I Summer Inservice Program

for

Elementary and Secondary Teachers of Physical Science
Austin Metropolitan Community,
Pharr-San Juan-Alamo ISD, and
Region 1 Educational Service Center

U.S. DEPARTMENT OF EDUCATION
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Final Performance Report

Prepared by

Frank E. Crawley, EdD
Project Director

Submitted to the

Texas Higher Education Coordinating Board

November, 1988

SE 050 590

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INTRODUCTION

The past five years are best described as a period of research, recommendation, and reform regarding precollege education. More than 200 local, state, and national task forces have studied the schooling process and issued reports criticizing the state of precollege education. Particularly hard hit have been precollege programs in science and mathematics. That achievement in these subjects has undergone a sharp decline in the past 20 years has been well documented at local, state, and national levels. Although the complexity of the problem is widely acknowledged, the finger of blame has come to rest all too often on the declining quality of teachers. Academically talented teachers are seldom attracted to teaching, the reports show, and those who do become teachers are among the first to leave the profession. Moreover, studies of elementary and secondary curricula have shown that too many students study too little science. This finding has led many states to increase the time spent on science instruction in the elementary schools and raise the requirements in science for high school graduation. Increased graduation requirements along with more stringent course expectations for students have exacerbated the problem of the declining quality of science teachers.

The crisis in science education in Texas mirrors that of the nation. In its report titled Study of the Availability of Teachers for Texas Public Schools (1984), the Texas Education Agency documented the extent of the teacher supply/demand crisis in secondary science education. For several years teachers certified to teach science have been among the greatest in demand yet shortest in supply. For example, the applications to openings ratio for science teachers at the beginning of the 1983-84 school year was next to the lowest, exceeded only by mathematics. The shortage of applicants to fill teaching vacancies in science in the 1983-84 school year resulted in the hiring of 1 out of 5 teachers who were less than qualified to teach science.

Schools and school districts have been placed in a bind. Increased course and graduation requirements in science necessitate the hiring of more and better qualified science teachers. Unable to find qualified or certified science teachers some school districts have resorted to "making do in the classroom". In their report titled "Making Do in the Classroom: A Report on the Misassignment of Teachers"(1985), the Council for Basic Education and the American Federation of Teachers provided state by state documentation to show that assigning teachers to teach subjects for which they have little academic preparation is completely legal. Faced with the task of offering more sections of existing science courses, school districts have exercised their legal authority and have assigned teachers to teach science courses for which they have limited academic preparation. Unfortunately, only a few states maintain records to document the extent to which teachers are misassigned.

Out-of-field teaching can and does occur in Texas. A school district need only issue to any certified teacher an Emergency Permit (<12 semester hours preparation) or a Temporary Classroom Assignment Permit (≥12 semester hours preparation). No records are maintained by the Texas Education Agency as to the extent to which school districts issue either Emergency or Temporary Classroom Assignment Permits. The misassignment of teachers is both legal and a common practice.

Improved instruction in traditional basic science skills will not prepare today's students to face tomorrow's world. Changing world and national economies have made obsolete the learning of only basic vocabulary and minimal problem solving skills in science and mathematics. Low skilled industrial jobs, traditionally available in great numbers to high school graduates, long ago shifted from the United States to Japan and more recently on to Korea. Korean factory workers are well trained in the basic problem solving skills needed in science and mathematics, moreover they are

willing to work long hours for low pay with the hope of improving their standard of living. The shift in technology and its invested capital to Japan and now on to Korea poses serious threats in the coming years to the high standard of living traditionally enjoyed by all Americans.

To protect and sustain the economic security and high standard of living traditionally enjoyed by all its citizens America's schools must graduate students who can reason and perform complex, non-routine tasks related to science and mathematics. People who are equipped to reason and think independently will be best prepared to function in, what has come to be called, a knowledge based economy, where the productivity of goods and services will be driven by highly advanced and sophisticated technology. To produce citizens of this high caliber the current educational system does not need to be repaired, in the words of the Carnegie Corporation's Task Force on Teaching as a Profession; instead "... it must be rebuilt to match the drastic change needed in our economy if we are to prepare our children for productive lives in the 21st century" (1986, p 14).

Mandates for dramatic improvement in the quality of pre-college science instruction require that improved continuing educational opportunities be made available to teachers of all science subjects, but particularly teachers of general education science courses which are taken most frequently by all students, regardless of ability or educational goals, to meet graduation requirements. Inservice programs must be provided for teachers to become acquainted with the rapid changes taking place in the subjects they teach, the interactions and mutually supportive roles played by science and technology, and the emerging issues in technology. Professional programs designed to accomplish these goals require collaboration among universities, business, and schools.

The Institute in Physical Science was developed to address the need for updated information and training in physics, chemistry, and technology among teachers of physical science throughout the Austin metropolitan community, the Pharr-San Juan-Alamo ISD, and the Region 15 Educational Service Center, particularly the less than qualified teachers. The program was funded by the Texas Higher Education Coordinating Board for the "Spring, Summer, and month of September, 1988, through two grants totalling $52, 184. The larger of the two grants ($41,325) targeted teachers of physical science in grades 5, 6, and 9/10, and the smaller grant ($10,859) targeted similar teachers in the Pharr-San Juan-Alamo ISD and Region 15 ESC. The project was conducted at the Science Education Center, University of Texas at Austin. Four major objectives were addressed by the project:

1. To improve secondary teachers' understanding of fundamental concepts in physics and chemistry;
2. To improve fifth and sixth grade teachers' understanding physical science and provide them with training in the use of physical science activities and investigations and the Essential Elements to teach physical science in grades five and six;
3. To provide high school physical science teachers with training in the use of activities and investigations stressing the development of the Essential Elements when teaching introductory physics and chemistry concepts included in the physical science course; and
4. To update teachers' knowledge of research in science education related to the teaching and learning of science and of research and development activities in physics, chemistry, and technology taking place within the Austin metropolitan community.

The sections of the report to follow include a description of the operation of the Institute in Physical Science and an evaluation of the project's effectiveness.

PROJECT OPERATION

The operation of the Institute in Physical Science project is described in the following sections, which adhere to the approximate timeline for the project.

Planning and Recruiting

During the Spring, 1988, plans were finalized for the Summer, 1988, Program. Four courses were planned and scheduled—Concepts in Chemistry, Concepts in Physics, Concepts in Physical Science, and Frontiers in Physical Science—and instructors were identified. Dr. Lowell Bethel, Assistant Dean for Teacher Education, developed and taught the course, Concepts in Physical Science, enrollment in which was restricted to teachers of physical science in grades 5 and 6. Mr. Ted Zoch, Associate Professor of Natural Science at Concordia Lutheran College, revised and served as instructor for the physics course titled, Concepts in Physics, restricted to secondary school teachers of physical science. Ms. Marianne Reese, Fellow in the Superintendency Program offered at the University of Texas at Austin, served for the third summer in a row as instructor of the chemistry course, Concepts in Chemistry, restricted to secondary school teachers of physical science. Dr. Frank Crawley, Project Director, developed and taught the course titled Frontiers in Physical Science, offered to elementary and secondary school teachers of physical science.

Brochures were designed, reproduced, and mailed to key administrators in each of the participating school districts in the Austin metropolitan area, to the science supervisor in the Pharr-San Juan-Alamo ISD, and to the science specialist in the Region 15 Educational Service Center, San Angelo, Texas. (A copy of the brochure describing the Institute in Physical Science Program is included in Appendix A). Approximately 350 brochures were mailed—to key administrators, to the principal in each high school located in the targeted, participating schools or school districts, and to teachers of physical science for whom addresses were on file. Principals were requested to distribute brochures to members of their science faculty who might be interested in attending the summer program.

Textbooks, laboratory equipment, and supplies were inventoried and replacements ordered. Course planning was begun for the elementary and secondary teachers who would be enrolled in the Frontiers in Physical Science course. Guest speakers representing each of the six participating high-tech manufacturers located in the Austin community were identified and arrangements were made for on site visits so teachers enrolled in the program could learn about a major aspect of work, related to physical science, currently underway at the local facility. Five of the six firms agreed to participate. Advanced Micro Devices could not participate due to the construction of a new wafer fabrication assembly line. Course outlines were developed, schedules planned, and room assignments completed for the four courses to be offered. Funds to replenish laboratory equipment and supplies for the Institute in Physical Science were requested and granted ($750) from Dr. Mario Benitez, Chairman of the Department of Curriculum and Instruction, University of Texas at Austin.

Participant Selection and Notification

Persons interested in participating in the Institute in Physical Science completed an application form which was mailed to them along with a brochure and returned the form to the Project Director. The Project Director visited teachers in the Pharr-San Juan-Alamo ISD to recruit and answer questions from potential applicants, teachers who had expressed interest in attending the Institute in Physical Science, 1988. A total of 39 teachers were selected from the Austin metropolitan community, 6 from the Pharr-San Juan-Alamo ISD, 1 from the Alice ISD,

Ha

end 2 from the Region 15 ESC. Participants were selected and notified during the last week of April, 1988. The following criteria were used to select participants.

1. Secondary applicants holding non-science certification assigned to teach one or more classes of physical science and elementary applicants lacking training in science.
2. Secondary applicants holding science certification but lacking preperation in physics, chemistry, and/or physical science and were assigned to teach one or more classes of physical science and elementary applicants lacking preperation in physical science.
3. Secondary applicants holding certification or endorsement in physical science who were assigned to teach physical science but who wanted to update their content knowledge and teaching skills in physical science and elementary applicants who wanted to update their content knowledge and teaching skills.
4. Applicants newly certified who wanted to strengthen their content knowledge and teaching skills in physical science.

To be considered for participation in the Institute in Physical Science applicants were required to submit along with the completed application a letter from a school administrator or district official supporting the applicant's participation in the Institute in Physical Science and granting permission for the applicant to lead a workshop for other physical science teachers in the district/school during the start of the school year, 1988-89. Acceptance letters were mailed to 48 experienced teachers, along with a University registration form.

Participant Characteristics

A total of 48 teachers were enrolled in the Institute in Physical Science, Summer Program. Tuition, fees, textbooks, and supplies were paid for the 48 teachers attending the Institute using funds provided by an EESA, Title II grant awarded by the Texas Higher Education Coordinating Board. Of the 48 teachers enrolled in the Institute, 28 held secondary teaching certificates, 18 held elementary certificates, 1 was completing certification program while teaching, and 1 was not certified or teaching. The elementary teachers (18) were endorsed to teach all subjects taught in the elementary grades. Nine secondary teachers held single subject, non-science certificates (Non-Sci); eighteen held single subject, science certificates (SS-Sci) but not physical science; and four held single subject, physical science certificates (SS-PS). Thirteen teachers were certified as composite science (Comp Sci). Data on the level and type of certification held by participants are found in Table 1.

Table 1
Entry Characteristics of Institute Participants
Level and Type of Teaching Certificate

Level of Certificate			Type of Certificate						
Non-Cert	Elem	Sec	All Sub	Non-Sci	SS-Sci	SS-PS	Comp Sci	Other	None
2	18	28	18	9	18	4	13	9	2

Note: 1 teacher reported both Comp Sci and SS-Sci, 2 teachers reported both Comp Sci and Other, and 2 teachers reported both SS-Sci and Other

Fourteen teachers taught one or more physical science classes during the Spring semester, 1988. The fourteen teachers taught a total of forty-seven (47) classes of physical science. Nine teachers taught one to four physical science classes while teaching other subjects. Five teachers

taught four to six physical science classes exclusively. The teaching assignment characteristics of teachers enrolled in the Institute in Physical Science, 1988, are found in Table 2.

Table 2
Entry Characteristics of Institute Participants (#)
Teaching Assignment

	Number of Physical Science Classes					
Teaching Assignment	1	2	3	4	5	6
PS and other classes	3	1	3	2	0	0
PS only	0	0	0	1	3	1

Eight teachers taught in major urban schools within cities with a population greater than 450,000, while seven teachers taught in major suburban schools. Four teachers taught in central cities (population 100,000 to 450,000), while two teachers taught in central city suburbs. Thirteen teachers taught in schools located in independent towns (population 25,000 to 100,000), nine taught in rural schools, and four teachers taught in schools in locations other than those listed. School location characteristics of the teachers enrolled in the Institute in Physical Science, 1988, are found in Table 3.

Table 3
Entry Characteristics of Institute Participants (#)
School Location

School Location						
Major Urban	Central City	Independent Town	Major Suburb	C City Suburb	Rural	Other
8	4	13	7	2	9	4

Note. 3 teachers did not report School Location

Of the 50 teachers attending the Institute in Physical Science, Summer Program, 8 were from Region 1 (6 from Pharr-San Juan-Alamo, 1 from Laredo, and 1 from Harlingen). One teacher came from Region 2 and one from Region 6. Further, 4 teachers came from Region 12, 30 from Region 13, 1 from Region 14, and 3 from Region 15. Two participants were currently not teaching. Region characteristics of the teachers are found in Table 4.

Table 4
Entry Characteristics of Institute Participants (#)

Regional Service Center						
#1	#2	#6	#12	#13	#14	#15
8	1	1	4	30	1	3

Note. 2 participants were currently not teaching

Four courses were offered to teachers attending the Institute in Physical Science, Summer, 1988. Twenty-one teachers were enrolled in "Concepts in Chemistry" (CH), eighteen in the "Concepts in Physics" (PH), twenty-two in "Frontiers in Physical Science" (FIPS), and twenty in "Concepts in Physical Science" (PS). Nineteen teachers were enrolled in one course only and thirty-one teachers in two courses. The greatest number of teachers were enrolled in both Chemistry and Physics (n=11, 22%). Table 5 contains enrollment preferences for the four courses offered.

Table 5
Enrollment Preference

	CH	PH	FIPS	PS	CH+PH	CH+FIPS	PH+FIPS	PH+PS	FIPS+PS
Count	2	4	3	10	11	8	2	1	9
%	4	8	6	20	22	16	4	2	18

Participants in the Institute in Physical Science varied greatly in their teaching experience. The 58 elementary and secondary teachers varied in teaching experience from 0 to 23 years, accounted for a total of 424 years in the classroom, and had an average of 8.48 years of teaching experience. Table 6 contains descriptive data concerning the teaching experience of the Institute participants.

Table 6
Teaching Experience of Institute Participants

Count	Minimum	Maximum	Total	Average	Deviation
48	0	23	424	8.48	5.51

Teachers enrolled in the Summer Program were asked to specify their major reason(s) for attending the Institute in Physical Science. Although teachers were free to check more than one reason, most teachers attended the Institute in Physical Science to improve the methods they use to teach physical science (68.7%), because of an "interest in physical science" (47.9%). Additional reasons cited included "to obtain instructional materials" (45.8%), "other" (22.9%), to complete "certification requirements" (20.8%), and to obtain "physical science endorsement" (12.5%). Table 7 contains data on the reasons offered by teachers for attending the Institute in Physical Science.

Of the 48 teachers attending the Institute in Physical Science, 20 had participated in an extended science inservice program in the past. The length of time since science teachers previous attendance in a summer inservice program ranged from 1 to 18 years, with an average of 3 years. Financial aid was provided for 19 of the 20 teachers to attend a prior, extended science inservice session. Of the teachers 13 reported support from the National Science Foundation, 5 from past EESA grants, and 1 reported support from the Texas Education Agency. One teacher did not indicate past institute participation. Table 8 contains data on participants' record of attendance at a science teacher institute prior to attending the Institute in Physical Science.

Table 7
Reasons Cited for Attendance (%)

Reasons	Percent Responses
Certification Requirements	20.8
Physical Science Endorsement	12.5
Interest in Physical Science	47.9
Obtain Instructional Materials	45.8
Improve Physical Science Teaching Methods	68.7
Other	22.9

Table 8
Prior Attendance at a Teacher Institute

Attendance	General Questionnaire Results
No	27
Yes	20
Last Attended (yrs)	
Range	1-18
Average	3.0
Financial Support	
Yes	19
No	1
Source of Support	
NSF	13
EESA	5
TEA	1

Teachers expressed many needs prior to attending the Summer Institute in Physical Science. Regardless of the course in which they were enrolled, teachers reported that they would like but receive little or no assistance in their school district in learning new teaching methods, locating equipment and materials, stimulating critical thinking, using hands-on materials, acquiring instructional materials, getting science career information, and stimulating interest in physical science. The need for information on technical applications was expressed by most teachers enrolled in the Institute in Physical Science (30 of the 47 teachers reporting). By contrast, few teachers indicated they needed help maintaining discipline, planning lessons, teaching lessons, establishing instructional objectives, or planning small group work. Table 9 contains information about the needs of the teachers prior to attending the Institute in Physical Science.

Program Operation

The Summer Program began with a Welcoming Banquet, held in the College of Education on Sunday evening, June 5, 1988, from 4:00 - 6:30 pm. Participants registered, obtained name tags, and became acquainted with one another. At 4:30 pm participants were welcomed by the

Table 9
Needs of Teachers Prior to Attending Institute in Physical Science

Needs	Response Options		
	1	2	3
Establishing Objectives	28	12	7
Planning Lessons	35	7	5
Learning New Teaching Methods	10	27	10
Teaching Lessons	30	8	9
Developing Tests	24	16	6
Stimulating Critical Thinking	9	23	15
Acquiring Instructional Materials	14	20	13
Obtaining Subject Information	19	19	9
Implementing Discovery/Inquiry	18	17	11
Using Hands-On Materials	17	21	8
Getting Science Career Information	14	20	10
Illustrating Technical Applications	9	30	8
Locating Equipment/Materials	8	24	15
Maintaining Equipment	19	18	10
Planning Small Group Work	27	14	6
Maintaining Discipline	37	5	5
Articulating Instruction Across Grades	25	18	4
Stimulating Interest in Physical Science	16	20	10

Note: 1 = Usually do not need assistance
2 = Would like assistance but receive little or none
3 = Would like assistance and receive adequate assistance

Project Director, Dr. Frank E. Crawley, and introduced to faculty and staff. Next, a brief overview was given of the characteristics of the teachers attending the Summer Program, of the day-to-day operation of the program, and of problems concerning parking on campus. Brief meetings were held with each of the four course instructors, during which time participants were told about the course and given a course outline and textbooks. Teachers were also taken on a tour of the Science Education Center and shown the rooms in which they would be meeting for each course. Following the tour participants, instructors, and project staff were treated to dinner which consisted of Texas barbecue provided by Bill Miller's Barbecue.

Classes met for six weeks, June 6-July 8, 1988, with an additional week provided for teachers to work independently and to consult with course instructors on planning and preparing workshops to be conducted in the Fall, 1988, upon return to the school district. Concepts in Chemistry and Concepts in Physics courses met Monday, Wednesday, and Friday from 8:30 to 11:30 am (Physics) and 1:30 to 4:30 pm (Chemistry). The Frontiers in Physical Science course met on Tuesday and Thursday, 8:30 am to 2:00 pm. Concepts in Physical Science met three days a week for three hours per day (M, W, F, 8:30 to 11:30 am). Teachers who were enrolled in the Frontiers course attended presentations held in the laboratories of University chemists and physicists and at the facilities of representatives of Austin area "high-tech" manufacturers. Participants visited the laboratories and heard three presentations from University chemists: surface catalysis, protein crystallography, and neural networks: a model for storage and retrieval

of information. Teachers visited the research laboratories and heard presentations in physics titled: the Texas tokamak, scanning/tunneling microscopy, and the super conducting super collider (SSC). Five additional tours and presentations were conducted by representatives of Austin area high-tech manufacturers; these included automated manufacturing (IBM), propagation of sound in the sea (Tracor), remotely piloted vehicle: science not technology (Lockheed), digital electronics (Motorola), and composite structures to solve an electronics interconnection problem (Texas Instruments).

Teachers prepared and revised instructional materials for each of the eleven topics presented in the Frontiers in Physical Science course. By the end of the Summer Program, eleven sets of materials were revised and submitted for revision and typing prior to distribution to teachers before the start of the new school year.

During the summer program the Research Assistant, Mr. George F. Spiegel, designed and produced a logo to use on a T-shirt for Institute in Physical Science participants. A sample T-shirt was prepared and put on display in the Science Education Center office. Approximately 35 orders were taken for T-shirts, at a cost of $8.00 each. T-shirts arrived and were distributed to teachers on Wednesday, July 6. It was agreed at this time that all participants, instructors, and staff would wear Institute in Physical Science T-shirts to the Closing Banquet.

On Friday, July 8, the Closing Banquet was held for participants in the Institute in Physical Science. The noonday luncheon meeting consisted of a salad and sandwich buffet provided by the project staff. The Project Director (Dr. Frank E. Crawley) and Assistant Director (Dr. Lowell J. Bethel) offered several closing remarks, presentations, and announcements. Participants were reminded about the Teacher Workshops they were planning, preparing, and presenting at the beginning of the Fall, 1988, semester to teachers in their schools/districts. The helpful assistance of course instructors and project staff was recognized and applauded. At the conclusion of the Closing Banquet, teachers were given a Certificate of Program Completion (designed by Mr. George F. Spiegel).

PROJECT EVALUATION

During the last class meeting in each course participants completed five instruments designed to quantify the success of the Program. These instruments included the following:

1. Content Test - A test given at the beginning and end of the Concepts in Chemistry, Concepts in Physics, and Concepts in Physical Science courses and at the end of the Frontiers in Physical Science course, to measure participants' gain in knowledge of the concepts addressed in each course in which they were enrolled.
2. General Questionnaire - A questionnaire (3 pages, 12 items) developed to collect information about teachers' needs prior to attending the Summer Institute in Physical Science and the extent to which their needs were met by the instructors of each course.
3. Program Evaluation - A Likert-type instrument (2 pages, 19 items) developed to measure participants' attitudes concerning the general operation and requirements of the Institute.
4. Course/Instructor Evaluation - A modified version of the standard Course/Instructor Survey used throughout the University (1 page, 23 items) designed to provide instructors with information concerning participants' evaluation of the effectiveness of the course and the instructor.
5. Activities and Investigations Questionnaire - A questionnaire (7 pages, 59 items) developed to measure the extent to which participants intended to use the activities and investigations produced in the courses in which they were enrolled, their attitude toward

use of the instructional materials, and the social pressures on teachers to use the materials. Furthermore, the Questionnaire asked for information about the participant (sex, age, and school location), the participant's preparation to teach (area of certification), and the participant's teaching experience (years teaching, years teaching science, and years teaching physical science).

The resulting data collected using each of these instruments are presented in the following sections (A copy of each instrument, except the content tests, is included in the Appendices). The concluding section of the Final Performance Report addresses the question of project effectiveness, i.e., the extent to which the Institute in Physical Science accomplished its objectives.

Knowledge Gain

Instructors developed and administered a content test at the beginning and end of the course. Test questions were developed to measure knowledge of each course's objectives. Instructors were free to develop any type of test, provided that the test questions were representative of the content to be covered and the objectives to be stressed the course.

Most teachers entered the Institute in Physical Science lacking background training or courses in the subjects they studied. This was particularly true of teachers registered for the Frontiers in Physical Science course, which included presentations by three distinguished University researchers in chemistry and three in physics about their most recent research accomplishments as well as presentations by representatives of five Austin area "high tech" firms about most recent product research and development activities related to physical science.

Pretests were administered during the first class meeting to teachers enrolled in the Concepts in Chemistry, the Concepts in Physics, and the Concepts in Physical Science courses, but a pretest was not administered to teachers enrolled in the Frontiers in Physical Science course. The decision not to administer a pretest in the Frontiers course was based on the observation that information included in the Frontiers presentations was unfamiliar to teachers and was not contained in any of the textbooks included on the list of textbooks approved for local adoption by school districts throughout the State of Texas.

Pretest scores were lowest for participants enrolled in the Concepts in Physical Science course. The content knowledge of teachers enrolled in the physical science, chemistry, or physics courses increased significantly from pre- to posttest ($p \leq .01$). In addition to improved content knowledge, the variability among teachers' in their knowledge of chemistry was reduced between pre- and posttests. Teachers improved their understanding of physics from pre- to posttest, although instruction appears to have been differentially effective to some extent, as is evidenced by an increase in the standard deviation from beginning to end of course. On the average, teachers enrolled in the Frontiers in Physical Science course mastered better than 63% of the course content, consisting of recent research and development activities of University and "high tech" scientists. Table 10 contains the descriptive data for teachers enrolled in Physics, Chemistry, Physical Science, and Frontiers in Physical Science courses and results of correlated sample t tests for significance of the difference in teachers' pre/post knowledge of physical science, physics, and chemistry.

Teachers' Needs

Teachers entered the Institute in Physical Science, Summer Program, with many needs related to the teaching of physical science. What is obvious from teachers' responses is that they attended the Institute in Physical for renewal. Justification for this conclusion is based on the

Table 10
Tests of Teachers' Content Knowledge

Course	n	M Pre	M Post	SD Pre	SD Post	t	p
Chemistry	20	68.52	86.76	15.31	9.13	7.10	.0001
Physics	18	64.44	78.44	7.87	9.81	6.44	.0001
Physical Science	18	47.06	56.00	10.72	10.35	3.59	.0023
Frontiers	22	—	63.54	—	9.49	—	—

Note. Maximum score range 0 to 100.

observation that all teachers, regardless of the course for which they were registered, wanted to learn new teaching methods, find out how to stimulate critical thinking among students, acquire instructional materials, obtain information about science careers, and gain ideas concerning technical applications of concepts taught in physical science. The need for information on technical applications was expressed by most teachers enrolled in the Institute in Physical Science. More traditional teacher needs received few mentions, e.g., how to maintain discipline, plan lessons, teach lessons, plan small group work, or establish instructional objectives.

At the end of the institute teachers were asked to indicate which needs were adequately met by their instructor, using the General Questionnaire. The institute instructors were particularly effective, as evidenced by teachers responses, in providing them with ideas for stimulating student interest in physical science, helping them obtain subject information, in providing them with instructional materials, information on technical applications of physical science concepts, establishing objectives, stimulating critical thinking, hands on teaching materials, and learning new teaching methods. Needs not adequately met by the instructors included the areas of maintaining science equipment, appropriate student discipline, and developing tests.

Over half the teachers reporting indicated that the instructors met their needs in the areas of planning lessons, getting science career information, and locating equipment/materials. Table 11 contains data on the extent to which teachers' needs were adequately met by the course instructors.

Program Evaluation

Participants were asked to indicate their feelings about returning to college and to evaluate specific features of the Institute in Physical Science. Generally speaking, teachers were not anxious about returning to school for additional training or about obtaining the training at the University of Texas at Austin. Participants expressed agreement that the Welcoming Banquet helped to clarify institute expectations. The duration of the institute and the time spent in class each day were acceptable to participants, although teachers enrolled in the Frontiers course were less certain about the length of time they spent in class. Teachers tended to agree that the resource guides prepared in each course would be useful to them when teaching the following school year and that the textbooks and materials were well chosen for each course. Further, according to institute participants, teacher-conducted workshops are an effective means for sharing activities and investigations with other teachers. There was agreement among teachers that they would use the course materials, activities, and investigations when teaching during the following year.

Table 11
Instructors Attention to Needs of Participants

Needs	Responses Yes	No
Establishing Objectives	29	19
Planning Lessons	27	21
Learning New Teaching Methods	28	20
Teaching Lessons	15	33
Developing Tests	13	35
Stimulating Critical Thinking	29	19
Acquiring Instructional Materials	32	16
Obtaining Subject Information	36	12
Implementing Discovery/Inquiry	22	26
Using Hands-On Materials	28	20
Getting Science Career Information	27	21
Illustrating Technical Applications	32	16
Locating Equipment/Materials	26	22
Maintaining Equipment	8	40
Planning Small Group Work	16	32
Maintaining Discipline	10	38
Articulating Instruction Across Grades	23	25
Stimulating Interest in Physical Science	37	11

Note. Not all participants responded to all items, and some participants indicated a need was both met and not met.

There tended to be strong agreement among participants that the Institute in Physical Science Program had been successful. Teachers indicated that the program was well organized and that staff members were helpful. Furthermore, participants agreed that the Institute accomplished its four goals:

1. To improve physical science teachers' understanding of fundamental concepts in physics and chemistry;
2. To improve fifth and sixth grade teachers' understanding of physical science and provide them with training in the use of physical science activities and investigations and the Essential Elements to teach physical science in grades five and six;
3. To provide high school physical science teachers with training in the use of activities and investigations stressing the development of the Essential Elements when teaching introductory physics and chemistry concepts included in the physical science course; and
4. To update teachers' knowledge of research in science education related to the teaching and learning of science and of research and development activities in physics, chemistry, and technology taking place within the Austin metropolitan community.

Overall, teachers strongly agreed that the Institute in Physical Science was a success, that they would encourage teachers to apply for other Institute Programs, and that they would like their

name added to the mailing list to be considered for future training programs held at the Science Education Center. Results of the program evaluation are found in Table 12.

Course/Instructor Evaluation

Participants in each course were asked to complete a Course/Instructor Evaluation, a modified version of the Course/Instructor Survey used by students throughout the University to evaluate courses and instructors. Only minor changes were made in the wording of items to be consistent with the nature of the courses offered in the Institute in Physical Science. On occasion an item was deleted when it was thought to be inappropriate for the four courses offered. Additional items were added to better address the purpose of the Institute courses.

Results of the Course/Instructor Evaluation were overwhelmingly favorable, although there were minor variations in opinion expressed by teachers about individual courses and instructors. Participants thought that instructors were well prepared, class time was well spent, they were free to ask questions, the instructor was intellectually stimulating, and the instructor revealed enthusiasm for teaching the course. In addition, activities and discussions clarified concepts taught in the Chemistry, Physics, and Physical Science courses. The teachers in the Frontiers course were uncertain as to how much the activities and discussions clarified concepts for them.

Tests appear to have met with mixed reactions from teachers enrolled in the four courses. Teachers enrolled in the Chemistry, and those in the Physical Science course, thought test questions were clear and covered topics included in the respective courses. There was less certain agreement among teachers in the Physics and the Frontiers course concerning the clarity and appropriateness of test questions.

All participants, regardless of the course, thought that instructors were interested in making participants better science teachers. In addition, teachers believed that they had learned much information applicable to teaching physical science, that the texts and references were well chosen, and that class activities were appropriate to their needs. Furthermore, teachers found the course(s) to be interesting, enjoyed attending class, and believed that they would be satisfied with their final course grade. Teachers agreed that they would use the information gained in the courses when teaching physical science.

After participating in the Institute courses teachers expressed an increased interest in teaching physical science. The number of topics covered in the Frontiers course and the pace of the Physics and the Frontiers courses needed to be improved, according to teachers. Regardless of pace and topic coverage, teachers indicated that they would recommend the courses to other teachers interested in physical science. The results of the Course/Instructor Evaluation are presented in Table 13.

Activities and Investigations Questionnaire

One of the major outcomes of the Institute in Physical Science was to provide teachers attending the program with activities and investigations covering the content of the course in which they were enrolled. Each of the activities and investigations stressed the development of one or more science concepts through active use of the essential elements. Instructors provided teachers enrolled in their course with written materials suitable for use with students they would be teaching at the start of the new school year. Chemistry, Physics, and Physical Science course materials stressed investigative experiences and included the purpose, equipment, essential elements, and procedures to be followed for each activity/investigation and contained summary and extension questions. Instructional materials developed in the Frontiers in Physical Science course

Table 12
Participants' Evaluation of Institute in Physical Science

Item	Response Average
Before attending the Institute in Physical Science, I was anxious about going back to school.	1.98
I was anxious about attending a summer program held at UT-Austin.	1.96
The Welcoming Banquet helped to clarify institute expectations, procedures, and requirements.	3.95
Five weeks is an appropriate length of time for the institute.	3.96
The length of time for each class meeting was acceptable	
- Three hours per meeting for chemistry/physics/physical science	4.20
- Five and a half hours per class meeting for Frontiers in Physical Science.	3.57
The resource guides will be useful for teaching physical science.	4.24
The textbooks and materials used in each course were well chosen.	4.26
Teacher-conducted workshops are an effective means for spreading the word to other teachers about institute activities/investigations.	4.23
I intend to use the course materials, activities, and investigations when teaching physical science.	4.36
The Institute in Physical Science was well organized.	4.39
Members of the institute staff were helpful.	4.58
The Institute in Physical Science accomplished its goals:	
- to improve secondary teachers' understanding of fundamental concepts in physics and chemistry,	4.35
- to improve fifth and sixth grade teachers' understanding of physical science and provide them with training in the use of physical science activities and investigations and the Essential Elements to teach physical science in grades five and six,	4.07
- to provide high school physical science teachers with training in the use of activities and investigations stressing the development of the Essential Elements when teaching introductory physics and chemistry concepts included in the physical science course, and	4.23
- to update teachers' knowledge of research in science education related to the teaching and learning of science and of research and development activities in physics, chemistry, and technology taking place within the Austin metropolitan community.	4.32
Overall, the Institute in Physical Science was a success.	4.50
I will encourage teachers to apply for the Institute in Physical Science programs.	4.57
I would like my name to be added to the mailing list to be considered for future teacher training programs held at the Science Education Center.	4.68

Note: 1 = Strongly Disagree 2 = Disagree 3 = Uncertain 4 = Agree 5 = Strongly Agree

Table 13
Participants' Evaluation of Courses and Instructors

Item	Courses			
	Chemistry	Physics	Frontiers	Physical Science
The instructor was well prepared for class.	4.50	4.65	4.40	4.67
Class instruction was time well spent.	4.45	4.24	3.00	4.47
The instructor made me feel free to ask questions and express my ideas.	4.83	4.35	4.19	4.89
The instructor was intellectually stimulating.	4.75	4.65	4.10	4.72
The instructor revealed enthusiasm for teaching the course.	4.75	4.82	4.43	4.89
Activities and discussions clarified concepts for me.	4.75	4.00	3.00	4.56
The instructor gave adequate instructions for activities, investigations, and assignments.	4.33	3.71	3.34	4.28
Test questions were clear.	4.25	3.65	3.62	4.11
Tests questions covered topics included in the course.	4.50	4.13	3.86	4.33
The texts and references used in the course were appropriate.	4.50	3.94	4.05	4.22
Class activities were appropriate to my needs.	4.50	3.77	3.52	4.35
The instructor seemed interested in making me a better teacher of physical science.	4.92	4.35	4.38	4.89
I learned much material applicable to teaching physical science.	4.82	4.53	3.95	4.44
I will probably be satisfied with my grade in this course.	4.50	4.29	4.14	4.11
I found this course to be interesting.	4.58	4.53	4.29	4.83
I enjoyed attending class.	4.67	4.41	3.90	4.83
I will recommend this course to other teachers interested in a physical science course.	4.75	4.29	3.86	4.78
I will use the information covered in this course when I teach science.	4.83	4.53	4.24	4.61
This course has increased my interest in teaching physical science.	4.50	4.41	4.19	4.65
The pace of the course was about right.	4.08	3.59	2.57	4.33
The number of topics covered was sufficient.	4.42	4.24	3.33	3.88

Note: 1 = Strongly Disagree 2 = Disagree 3 = Uncertain 4 = Agree 5 = Strongly Agree

stressed new information supplemented with activities and investigations appropriate for use when introducing the new topics. Information included recent research and development activities taking place in the Austin community, particularly among chemists and physicists at UT-Austin and among researchers in five "high tech" manufacturers located in Austin. Although it would be impossible to visit each teacher during the following school year to see the instructional materials in use, information was sought regarding teachers' intention to use the activities and investigations with students during the new school year. Social psychology offers a theoretical basis for linking teachers' use of the instructional materials with their intention to do so, their

attitude toward using the materials, the social pressures that exist, and the extent to which teachers perceive they have control over the decision to use the materials or not.

The Theory of Planned Behavior, a recent modification of the Theory of Reasoned Action, was developed by social psychologists to better understand and predict human behavior. The Theory of Reasoned Action was developed by Ajzen and Fishbein (1975) and has been found to be extremely successful in explaining diverse human behaviors such as drinking, dieting, choosing a career, planning a family, voting, and purchasing a product (1980). In education, the Theory of Reasoned Action has been used to gain information about the intent of grade 8 students to enroll in a high school science course (Crawley, & Coe, In Press). According to the theory, the best predictor of someone's behavior is the person's intention to perform the behavior, provided the behavior is truly volitional. Intention to engage in a specific behavior has been shown to be determined by two variables, one personal and the other social. Attitude toward the behavior, the personal component, represents the extent to which a persun believes that performing a behavior will lead to desirable consequences. Subjective norm, the social component, is a measure of the extent to which an individual believes that important "others" think the behavior should be performed.

Only recently has the Theory of Reasoned Action been extended to address behaviors that can not be considered to be truly volitional. The Theory of Planned Behavior (Ajzen, & Madden, 1986) has been used successfully to account for behaviors whose performance are not completely under the control of the individual, e.g., getting a grade of "A" in a college course. Attitudes, subjective norm, and perceived behavioral control, and intention are the four variables, according to the Theory of Planned Behavior, needed to predict and understand behavior.

An Activities and Investigations Questionnaire was constructed following the prescribed methods (Ajzen, & Fishbein, 1980; Ajzen, & Madden, 1986). During the last class meeting information was collected from teachers in each course concerning their intention to use 50% of the activities and investigations developed and used in the Institute courses, with the students they would teach during the following school year. In addition, teachers completed items that assessed their attitude toward the behavior (i.e., using 50% of the activities and investigations developed and used in the Institute in Physical Science courses with the students teachers would teach during the following school year). In addition, teachers indicated whether most people important to them thought they should perform the behavior (i.e., use 50% of the activities and investigations developed and used in the Institute in Physical Science courses with the students they would teach during the following school year) and the extent to which teachers perceived that they could freely choose whether they would engage in the behavior.

Intentions to perform the behavior, attitudes toward the behavior, subjective norm, and perceived behavioral control data were obtained from each participant enrolled in each course [Note: Of the 50 participants 18 were enrolled in 1 course only and 32 were enrolled in 2 courses]. Teachers' intentions to use the activities and investigations were similar in Chemistry and Physics. Teachers enrolled in the Physical Science course reported stronger intention scores than did teachers enrolled in any of the other three courses. Teachers enrolled in the Frontiers in Physical Science course were rather uncertain as to their future use of the activities and investigations. The greatest variation in the group scores occurred on teachers' attitude toward use of the activities and investigations. Scores ranged from a low of 7.80 to a high of 9.78 (possible score range = -12 to 12). Subjective norm scores were somewhat higher for teachers enrolled in the Physical Science course. All teachers expressed the belief that the decision to use the activities and investigations was theirs alone to make. Table 14 contains descriptive data on intention, attitude, subjective norm, and perceived behavioral control for participants enrolled in each of the four courses.

Table 14
Descriptive Data on Outcomes by Course

	Course							
	Chemistry		Physics		Frontiers		Physical Science	
Outcome	Mean	SD	Mean	SD	Mean	SD	Mean	SD
Intention	1.76	1.41	1.44	1.46	0.05	1.54	2.22	1.17
Attitude	9.05	2.40	8.13	2.39	7.80	1.85	9.78	2.26
Subjective Norm	2.14	0.96	2.19	0.83	2.16	0.69	2.44	0.71
Perceived Behavioral Control	30.45	2.68	30.93	3.01	28.30	3.57	30.94	3.25

Note: Score range = -3 to 3 for Intention and Subjective Norm , -12 to 12 for Attitude, and 7 to 35 for Perceived Behavioral Control, in integer steps.

The means were analyzed separately for the four outcomes for teachers enrolled in the Chemistry, Physics, Physical Science, and Frontiers courses, using analysis of variance techniques. No differences were found in the subjective norm scores, but differences were detected in intention, attitude and perceived behavioral control attributable to the course in which teachers were enrolled. Table 15 contains the results of significance tests.

Table 15
Results of Separate ANOVAs for Four Outcomes

Outcome	Effect	SS	df	MS	F	p
Intention	Course	51.18	3	17.06	8.66	.0001
	Error	139.81	71	1.97		
Attitude	Course	44.93	3	14.98	3.01	.0357
	Error	353.01	71	4.97		
Subjective Norm	Course	1.12	3	0.37	0.57	.6394
	Error	45.98	73	0.66		
Perceived Behavioral Control	Course	89.63	3	29.88	3.01	.0361
	Error	675.03	68	9.93		

Follow-up tests were conducted to identify score differences for each of the three outcomes found to be significant as a result of ANOVA tests. Employing the conservative Scheffe' Test, differences attributable to course enrollment were found for intention to use the activities and investigations but not for attitude and perceived behavioral control. Intention differences favored use of the materials produced in the physics (PHY), chemistry (CHM), and physical science (PS) courses more so than the materials produced in the Frontiers in Physics Science (FIPS) course. Results of tests for significance differences in outcome scores by course are presented in Table 16.

According to the Theory of Planned Behavior, intention to perform a behavior is related to attitude toward the behavior, subjective norm, and perceived behavioral control. Teachers'

Table 16
Outcome Differences by Course

Outcome	Course\Course	PHY	CHM	FIPS	PS
Intention	PHY		0.32	-1.39	0.78
	CHM			-1.71	0.46
	FIPS				2.17
	PS				
Attitude	PHY		0.92	-0.32	1.65
	CHM			-1.25	0.73
	FIPS				1.98
	PS				
Perceived Behavioral Control	PHY		0.48	-2.63	0.01
	CHM			-2.15	0.49
	FIPS				2.64
	PS				

Note: Scheffe Test used to identify significant contrasts, $p \leq .05$

Intention to use the activities and investigations with the students they would teach during the following school year was determined to be related to their attitude toward using the materials for teachers enrolled in the physics course but not for teachers enrolled in the chemistry, physical science, or frontiers in physical science course. Moreover, neither subjective norm nor perceived behavioral control were found to be significantly related to intention. Results of the computation of an intercorrelation matrix for teachers enrolled in each of the four courses to determine the degree of association among the four outcomes—intention, attitude, subjective norm, and perceived behavioral control — are presented in Table 17.

Table 17
Outcome Intercorrelations by Course

		Course			
Outcome		Chemistry	Physics	Frontiers	Physical Science
Intention/Attitude	r	.33	.50	.30	.47
	p	.1457	.0490	.1999	.0515
Intention/ Subjective Norm	r	.17	.09	.25	.23
	p	.4520	.7335	.3073	.3570
Intention/Perceived Behavioral Control	r	.33	.07	.05	.18
	p	.1570	.9822	.8190	.4950

The extent to which intention can be predicted from attitude, subjective norm, and perceived behavioral control data was tested using multiple regression techniques. According to the Theory of Planned Behavior behavioral intention is the best predictor of behavior, and attitude toward the

behavior, subjective norm, and perceived behavioral control are the best predictors of intention. Attitude, subjective norm, and perceived behavioral control were found not to significantly aid in the prediction of behavioral intention for teachers enrolled in any one of the courses. Combining the data for all courses revealed attitude to be the sole predictor of teachers' intentions to use the activities and investigations with student they would teach during the following school year. Data on the regression of intention on attitude, subjective norm, and perceived behavioral control are presented in Table 18.

Table 18
Regression of Intention on Attitude, Subjective Norm, and Perceived Behavioral Control

Course	Source	df	SS	MS	F	p
Chemistry	Regression	3	7.50	2.50	1.24	.3277
	Residual	16	32.25	2.02		
Physics	Regression	3	11.12	3.71	1.99	.1738
	Residual	11	20.48	1.86		
Frontiers	Regression	3	6.96	2.32	.92	.4564
	Residual	15	37.98	2.53		
Physical Science	Regression	3	6.37	2.12	1.82	.1934
	Residual	13	15.16	1.17		
Combined	Regression	3	49.62	16.54	8.99	.0001
	Residual	67	138.58	2.07		

The independent contributions of attitude, subjective norm, and perceived behavioral control to the prediction of behavioral intention were determined by examining the relative magnitudes of the coefficients in the regression equation for the four courses, separately and combined. Attitude was determined to be the sole predictor of behavioral intention for teachers enrolled in the physics course ($p \leq .05$). Combining the data for all course resulted in a significant contribution from attitude to the prediction of behavioral intention but not from subjective norm or perceived behavioral control. Data on the independent contributions of attitude, subjective norm, and perceived behavioral control to the prediction of behavioral intention are found in Table 19, analyzed for each course separately and for the combination of the four courses.

PROJECT EFFECTIVENESS

The Institute in Physical Science brought to the campus of the University of Texas at Austin 50 experienced elementary and secondary teachers of physical science for the summer program, 1988. Participants represented private and public schools; city, suburban, and rural schools; and certified and non-certified, elementary and secondary school teachers from schools located in the central Texas region, Pharr-San Juan-Alamo ISD, and Educational Service Center, Region 15. Although "interest in physical science" and "obtain instructional materials" were major reasons cited by teachers for attending the Institute in Physical Science, Summer Program, the primary need given was to "improve physical science teaching methods". For more than half of the teachers the Institute in Physical Science was the first summer or academic year program designed specifically for teachers of science that they had ever attended.

Teachers entered the Institute in Physical Science with a variety of needs. They reported that they would like but receive little or no assistance in their district in learning new teaching methods, stimulating critical thinking, acquiring instructional materials, getting science career

Table 19
Regression Coefficient Table by Course

Course	Outcome	Beta	t	p
Chemistry	Attitude	.31	1.17	.2588
	Subjective Norm	-.03	0.10	.9222
	Perceived Behavioral Control	.24	0.97	.3446
Physics	Attitude	.58	2.25	.0461
	Subjective Norm	.26	1.06	.3108
	Perceived Behavioral Control	-.24	0.91	.3826
Frontiers	Attitude	.30	1.26	.2257
	Subjective Norm	.25	1.06	.3051
	Perceived Behavioral Control	.04	0.17	.8642
Physical Science	Attitude	.47	1.92	.0765
	Subjective Norm	.12	0.48	.6372
	Perceived Behavioral Control	-.24	0.99	.3401
Combined	Attitude	.49	3.86	.0003
	Subjective Norm	.12	1.12	.2671
	Perceived Behavioral Control	.10	0.88	.3811

information, illustrating technical applications of concepts taught in physical science, locating equipment/materials, and stimulating interest in physical science. Most teachers' needs were adequately met by the instructor for the course(s) in which they were enrolled. Moreover, teachers registered significant gains in their knowledge of science. The program, courses, and instructors received extremely favorable evaluations from the teachers attending the Institute in Physical Science.

Evidence indicates that the Institute in Physical Science was successful in meeting its objectives. The objectives of the program were:

1. To improve secondary teachers' understanding of fundamental concepts in physics and chemistry;
2. To improve fifth and sixth grade teachers' understanding or physical science and provide them with training in the use of physical science activities and investigations and the Essential Elements to teach physical science in grades five and six;
3. To provide high school physical science teachers with training in the use of activities and investigations stressing the development of the Essential Elements when teaching introductory physics and chemistry concepts included in the physical science course; and
4. To update teachers' knowledge of research in science education related to the teaching and learning of science and of research and development activities in physics, chemistry, and technology taking place within the Austin metropolitan community.

Program evaluation data show that participants reported the Institute in Physical Science to have achieved, in their opinion, each of its four objectives (see Table 12).

Content knowledge data revealed that secondary school teachers significantly improved their understanding of fundamental concepts in physics and chemistry (Objective 1). Teachers enrolled in the Concepts in Chemistry and Concepts in Physics courses reached an average level of mastery of basic concepts in chemistry and physics exceeding the 75% level. Fifth and sixth grade teachers

enrolled in the Concepts in Physical Science course also registered significant gains in their understanding of physical science (Objective 2). Moreover, elementary and secondary school teachers enrolled in the Frontiers in Physical Science course reached an average level of mastery exceeding 60%, on information related to research and development activities in physics, chemistry, and technology taking place within the Austin metropolitan community (Objective 4).

Evidence indicates that elementary and secondary teachers were trained in the use of the essential elements to teach introductory chemistry and physics concepts included in the physical science course (Objectives 2 and 3) and that the instructional materials developed for use in their classrooms will be used during the 1988-89 school year. Self report data contained on the Program Evaluation completed by all participants show that teachers were provided with training in the use of the essential elements to teach basic concepts in the subject field(s) of study. None of the responses given by teachers indicated disagreement that the program had been successful in providing teachers with training in the use of the essential elements to teach physical science. Furthermore, all teachers reported that they intended to make use of the activities and investigations, which utilize the essential elements, when teaching physical science. Teachers enrolled in the Frontiers in Physical Science course were less intent on using the activities and investigations developed in the course than were teachers enrolled in the physics, chemistry, or physical science courses. A tentative explanation can be advanced for this finding. The activities and investigations developed are perceived to be, perhaps, of an enrichment nature, which precludes in the minds of teachers their use with all students in whole-class instruction. Additional information must be collected on the use of the "Frontiers" materials before definite conclusions can be reached regarding teachers' use of the activities and investigations produced in the Frontiers in Physical Science course.

As a result of the efforts of teachers enrolled in the Frontiers in Physical Science course, eleven sets of instructional materials have been prepared and distributed to participants, elementary and secondary teachers of physical science in the central Texas region, Pharr-San Juan-Alamo ISD, and Region 15 ESC. Each set of instructional materials includes objectives, content, activities/investigation, evaluation, and career opportunity sections. Topics contained in the Sourcebook include:

1. Surface Catalysis and Surface Science (Chemistry)
2. Protein Crystallography (Chemistry)
3. Nuclear Fusion and the Texas Tokamak (Physics)
4. Computer Integrated Manufacturing (IBM)
5. The Scanning Tunneling Microscope (Physics)
6. Propagation of Sound in the Sea (Tracor)
7. Remotely Piloted Vehicles (Lockheed, Austin Division)
8. Composite Structures (Texas Instruments)
9. Neural Networks, The Brain, and Dream Sleep (Chemistry)
10. Digital Electronics (Motorola)

The Institute in Physical Science proved to be a cost effective means of upgrading the quality of physical science education. The Program succeeded in improving secondary school teachers' knowledge of chemistry, physics, and recent research findings in physics, chemistry, and science education; improving fifth and sixth grade teachers' understanding of physical science and providing them with training in the use of physical science activities and investigations and the Essential Elements to teach physical science in grades five and six; providing high school physical science teachers with training in the use of activities and investigations stressing the development of the Essential Elements when teaching introductory physics and chemistry concepts included in the physical science course; and updating teachers' knowledge of research in science education

related to the teaching and learning of science and of research and development activities in physics, chemistry, and technology taking place within the Austin metropolitan community. Furthermore, the data overwhelming show that training provided in the Institute in Physical Science improved teachers' instructional skills and renewed their interest in and commitment to teaching physical science. With all 50 teachers expressing their intent to use the activities and investigations with their students, the Institute in Physical Science will have a pronounced, favorable impact on the quality of physical science instruction received by students in the elementary and secondary school classrooms throughout the Austin metropolitan community, the Pharr-San Juan-Alamo ISD, and Region 15 Educational Service Center.

Appendices

1. Institute in Physical Science Brochure
2. General Questionnaire
3. Program Evaluation
4. Course/Instructor Evaluation
5. Activities and Investigations Questionnaire

Application Procedures

Teachers interested in applying for admission to the Institute in Physical Science should submit the following:

1. a completed application (enclosed)
   and
2. a letter of recommendation.

The letter of recommendation should come from the school principal or district coordinator. This letter should address three items:

1. professional need of the applicant,
2. benefit of the applicant's participation to the school district, and
3. approval and support to lead a workshop for other teachers during the following school year.

Materials must be submitted by Friday, April 15,1988, to:

Frank E. Crawley, Institute Director
Institute in Physical Science
Science Education Center, EDB 340
The University of Texas at Austin
Austin, Texas 78712

For additional applications or information call:
Ms. Laura Avant, (512) 471-7354.

Science Education Center
Education Building, Room 340
The University of Texas at Austin
Austin, Texas 78712

INSTITUTE IN PHYSICAL SCIENCE

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A SUMMER PROGRAM
FOR
ELEMENTARY AND SECONDARY
TEACHERS OF PHYSICAL SCIENCE
IN THE
AUSTIN METROPOLITAN AREA,
EDUCATION SERVICE CENTER-REGION 15,
AND PHARR-SAN JUAN-ALAMO ISD

THE UNIVERSITY OF TEXAS AT AUSTIN
COLLEGE OF EDUCATION

JUNE 6 - JULY 8, 1988

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Science Education Center
The University of Texas at Austin
(512) 471-7354

Application Form
Institutes in Physical Science

Name_____ #Years Teaching_____ Grade Level(s)_____
(Last name) (First name) (MI or Maiden for registration purposes)

Social Security Number ___-___-____ (for registration purposes)

Home Address_____ City_____ Zip_____

School in which you presently teach_____ I.S.D._____

School Mailing Address_____ City_____ Zip_____

Education:

College/University attended	Dates	Major	Degree(s) granted

Home phone(___)___-_____ School phone(___)___-_____

Courses you presently teach and the number of classes of each (Secondary teachers only)

Course	Number of classes
1.	
2.	
3.	
4.	
5.	
6.	

Level(s) & Field(s) of Certification_____

Are you a former UT-Austin student ? YES NO (circle one) If YES, under what name ?_____

Are you presently enrolled in a graduate program ? YES NO (circle one)

If YES , in what institution are you currently enrolled ?_____

Are you interested in receiving information about admission to the Graduate School at UT- Austin ? YES NO (circle one)

Please check the courses you wish to take in the Institute in Physical Science (maximum of 2)

- ☐ Frontiers in Physical Science (all teachers)
- ☐ Concepts in Physical Science (Elementary teachers only)
- ☐ Concepts in Physics (Secondary teachers only)
- ☐ Concepts in Chemistry (Secondary teachers only)

Institute in Physical Science

General Questionnaire

Directions: Please take a few minutes to answer several questions regarding your reasons for attending the Institute in Physical Science and the extent to which your needs were met. Feel free to include at the end any additional comments that you think might be helpful in planning future institutes for teachers of science.

1. Name (Last, First, MI): _____

   Social Security Number: ___ ___ ___ - ___ ___ - ___ ___ ___ ___

2. What was your major reason for attending the Institute in Physical Science? (check as many as apply)
   - ☐ Complete certification requirements
   - ☐ Seek endorsement to teach physical science
   - ☐ Interested in physical science
   - ☐ Obtain instructional materials
   - ☐ Improve methods of teaching physical science
   - ☐ Other (please explain) _____

3. Prior to this summer have you ever attended a summer or academic year institute designed specifically for teachers of science? ☐ Yes ☐ No If yes, answer the following questions:
   - When did you last attend a teacher institute? (month and year) _____
   - Did you receive financial support to attend the teacher institute? ☐ Yes ☐ No If yes, what was the source of the funds? _____

4. Please indicate your needs prior to attending the Institute in Physical Science regarding assistance from a science education resource person (e.g., a science coordinator, a consultant, or another teacher) for each of the following: (Circle # on each line.)

		Usually Do Not Need Assistance	Would Like Assistance But Receive Little or None	Would Like Assistance and Receive Adequate Assistance
a.	Establishing instructional objectives	1	2	3
b.	Planning lessons	1	2	3
c.	Learning new teaching methods	1	2	3
d.	Actually teaching lessons	1	2	3
e.	Developing appropriate tests	1	2	3
f.	Stimulating critical thinking	1	2	3
g.	Obtaining information about instructional materials	1	2	3
h.	Obtaining subject matter information	1	2	3
i.	Implementing discovery/inquiry approach	1	2	3
j.	Using manipulative or hands-on materials	1	2	3
k.	Obtaining information about science careers	1	2	3
l.	Illustrating technical applications of physical science concepts	1	2	3

(Continued on next page)

		Usually Do Not Need Assistance	Would Like Assistance But Receive Little or None	Would Like Assistance and Receive Adequate Assistance
m.	Obtaining equipment/materials for activities and investigations	1	2	3
n.	Maintaining equipment	1	2	3
o.	Working with small groups of students	1	2	3
p.	Maintaining discipline	1	2	3
q.	Articulating instruction across grade levels	1	2	3
r.	Getting students interested in physical science	1	2	3

5. Please indicate which needs were adequately met by your instructor(s) in the Institute in Physical Science. (Circle letter designations, a-r)

a b c d e f g h i j k l m n o p q r

6. Please indicate which needs were NOT adequately met by your instructor(s) in the Institute in Physical Science. (Circle letter designations, a-r)

a b c d e f g h i j k l m n o p q r

7. When you think about other teachers in your school who teach physical science what do you see their most pressing needs to be? (Circle letter designations, a-r)

a b c d e f g h i j k l m n o p q r

If you are a high school science teacher, please answer the following questions.

8. What is the name of the high school in which you teach? _____

9. Is the physical science course required of all students (i.e., basic, regular, and advanced or gifted and talented) for high school graduation? Yes No (Circle one)

   If physical science is NOT a required course, which students are encouraged to enroll in physical science?
   Basic ☐ Regular ☐ Advanced/Gifted and Talented ☐ (Check as many as apply)

10. Overall, do physical science teachers in your school meet the TEA requirement for a laboratory science course, namely 40% of instructional time devoted to laboratory instruction? Yes No (Circle one)

11. Estimate the failure rate for students enrolled in physical science in your school (in %)
    _____ %

(Continued on next page)

12. How often do you use each of the following techniques in teaching your science class(es)? If a technique does not apply to your class(es), please circle 1, "Never".

	(Circle one on each line)				
	Never	Less Than Once A Month	At Least Once A Month	At Least Once A Week	Just About Daily
a. Lecture	1	2	3	4	5
b. Discussion	1	2	3	4	5
c. Student reports of projects	1	2	3	4	5
d. Worksheets	1	2	3	4	5
e. Laboratory	1	2	3	4	5
f. Televised instruction	1	2	3	4	5
g. Programmed instruction	1	2	3	4	5
h. Computer-assisted instruction	1	2	3	4	5
i. Tests or quizzes	1	2	3	4	5
j. Contracts	1	2	3	4	5
k. Simulations (role-play, debates, panels)	1	2	3	4	5
l. Field trips, excursions	1	2	3	4	5
m. Guest speakers	1	2	3	4	5
n. Teacher demonstrations	1	2	3	4	5

Thank you for your time, patience, and help.

In the space below feel free to offer any additional information concerning your needs and expectations, the needs of other teachers of physical science in your school, or the operation of the Institute in Physical Science Program.

Name: _____ SS# ___-___-_____

Activities and Investigations Questionnaire

Course: _____

General Directions: In the questionnaire you are about to complete we ask questions which make use of rating scales with seven places; you are to mark with an "X" in the place that best describes you opinion. For example, if you were asked to rate "The Weather in Austin" on such a scale, the seven places should be interpreted as follows:

The Weather in Austin

good _____ : _____ : _____ : _____ : _____ : _____ : _____ bad
extremely quite slightly neither slightly quite extremely

If you think the Weather in Austin is "extremely good", then you would place your mark as follows:

The Weather in Austin

good __X__ : _____ : _____ : _____ : _____ : _____ : _____ bad
extremely quite slightly neither slightly quite extremely

If you think the Weather in Austin is "quite bad", then you would place your mark as follows:

The Weather in Austin

good _____ : _____ : _____ : _____ : _____ : __X__ : _____ bad
extremely quite slightly neither slightly quite extremely

If you think the Weather in Austin is "neither good nor bad", then you would place your mark as follows:

The Weather in Austin

good _____ : _____ : _____ : __X__ : _____ : _____ : _____ bad
extremely quite slightly neither slightly quite extremely

You will also be using a rating scale with likely-unlikely as end points. This scale is to be interpreted in the same way. For example, if you were asked to rate "The Weather in Austin is Hot, June 6-July 8" on such a scale, it would appear as follows:

The Weather in Austin is Hot, June 6-July 8

likely _____ : _____ : _____ : _____ : _____ : _____ : _____ unlikely
extremely quite slightly neither slightly quite extremely

If you think that it is "extremely likely" that the Weather in Austin is Hot, June 6-July 8, you would make your mark as follows:

The Weather in Austin is Hot, June 6-July 8

likely __X__ : _____ : _____ : _____ : _____ : _____ : _____ unlikely
extremely quite slightly neither slightly quite extremely

In making your ratings please remember the following points:

1. Place your marks in the middle of spaces, not on the bounderies:

_____ : __X__ : _____ : _____ : _____ : _____X_____
this not this

2. Be sure you answer all items—please do not omit any.
3. Never put more than one "X" mark on a single scale.

Specific Directions: In this questionnaire we are mainly concerned with your views toward the behavior, "Use of 50% of the Activities and Investigations Completed in this Institute in Physical Science course With the Students I Teach Next School Year". To save reading time and space this behavior will be shortened to read, "Use of the Activities and Investigations With Students I Teach Next Year".

Intention

I intend to use the activities and investigations with students I teach next year.

more _____ : _____ : _____ : _____ : _____ : _____ : _____ less
considerably somewhat slightly 50% slightly somewhat considerably

Attitude toward the behavior

My use of the activities and investigations with students I teach next year is

beneficial _____ : _____ : _____ : _____ : _____ : _____ : _____ harmful
extremely quite slightly neither slightly quite extremely

good _____ : _____ : _____ : _____ : _____ : _____ : _____ bad
extremely quite slightly neither slightly quite extremely

rewarding _____ : _____ : _____ : _____ : _____ : _____ : _____ punishing
extremely quite slightly neither slightly quite extremely

pleasant _____ : _____ : _____ : _____ : _____ : _____ : _____ unpleasant
extremely quite slightly neither slightly quite extremely

Outcome Evaluations

1. Creating in students more interest in physical science is
good _____ : _____ : _____ : _____ : _____ : _____ : _____ bad
extremely quite slightly neither slightly quite extremely

2. Helping students to understand physical science is
good _____ : _____ : _____ : _____ : _____ : _____ : _____ bad
extremely quite slightly neither slightly quite extremely

3. Covering all the physical science topics included in my course (grade level) is
good _____ : _____ : _____ : _____ : _____ : _____ : _____ bad
extremely quite slightly neither slightly quite extremely

4. Boosting other teachers' interest in teaching physical science is
good _____ : _____ : _____ : _____ : _____ : _____ : _____ bad
extremely quite slightly neither slightly quite extremely

5. Helping students see applications of physical science concepts in their daily lives is
good _____ : _____ : _____ : _____ : _____ : _____ : _____ bad
extremely quite slightly neither slightly quite extremely

(Continued on next page)

6. Getting students actively involved in learning physical science is
good _____ : _____ : _____ : _____ : _____ : _____ : _____ bad
extremely quite slightly neither slightly quite extremely

7. Giving students experience using physical science equipment is
good _____ : _____ : _____ : _____ : _____ : _____ : _____ bad
extremely quite slightly neither slightly quite extremely

8. Developing in students the ability to use the vocabulary of physical science is
good _____ : _____ : _____ : _____ : _____ : _____ : _____ bad
extremely quite slightly neither slightly quite extremely

9. Helping students develop critical thinking and problem solving skills is
good _____ : _____ : _____ : _____ : _____ : _____ : _____ bad
extremely quite slightly neither slightly quite extremely

10. Teaching physical science to students of differing ages, abilities, and interests is
good _____ : _____ : _____ : _____ : _____ : _____ : _____ bad
extremely quite slightly neither slightly quite extremely

11. Clarifying for students the physical science concepts and principles they study is
good _____ : _____ : _____ : _____ : _____ : _____ : _____ bad
extremely quite slightly neither slightly quite extremely

12. Providing opportunities for students to interact with one another and the teacher is
good _____ : _____ : _____ : _____ : _____ : _____ : _____ bad
extremely quite slightly neither slightly quite extremely

13. Making physical science more interesting and fun is
good _____ : _____ : _____ : _____ : _____ : _____ : _____ bad
extremely quite slightly neither slightly quite extremely

Behavioral beliefs

1. My use of the activities and investigations with the students I teach next year will create in students more interest in physical science.
likely _____ : _____ : _____ : _____ : _____ : _____ : _____ unlikely
extremely quite slightly neither slightly quite extremely

2. My use of the activities and investigations with the students I teach next year will help students to understand physical science.
likely _____ : _____ : _____ : _____ : _____ : _____ : _____ unlikely
extremely quite slightly neither slightly quite extremely

3. My use of the activities and investigations with the students I teach next year still allows me to cover all the physical science topics included in my course (grade level).
likely _____ : _____ : _____ : _____ : _____ : _____ : _____ unlikely
extremely quite slightly neither slightly quite extremely

4. My use of the activities and investigations with the students I teach next year will boost other teachers' interest in teaching physical science.
likely _____ : _____ : _____ : _____ : _____ : _____ : _____ unlikely
extremely quite slightly neither slightly quite extremely

(Continued on next page)

5. My use of the activities and investigations with the students I teach next year will help students see applications of physical science concepts in their daily lives.

likely _____ : _____ : _____ : _____ : _____ : _____ : _____ unlikely
extremely quite slightly neither slightly quite extremely

6. My use of the activities and investigations with the students I teach next year will get students actively involved in learning physical science.

likely _____ : _____ : _____ : _____ : _____ : _____ : _____ unlikely
extremely quite slightly neither slightly quite extremely

7. My use of the activities and investigations with the students I teach next year will give students experience using physical science equipment.

likely _____ : _____ : _____ : _____ : _____ : _____ : _____ unlikely
extremely quite slightly neither slightly quite extremely

8. My use of the activities and investigations with the students I teach next year will develop in students the ability to use the vocabulary of physical science.

likely _____ : _____ : _____ : _____ : _____ : _____ : _____ unlikely
extremely quite slightly neither slightly quite extremely

9. My use of the activities and investigations with the students I teach next year will help students develop thinking and problem solving skills.

likely _____ : _____ : _____ : _____ : _____ : _____ : _____ unlikely
extremely quite slightly neither slightly quite extremely

10. My use of the activities and investigations with the students I teach next year will enable me to better teach physical science to students of differing ages, abilities, and interests.

likely _____ : _____ : _____ : _____ : _____ : _____ : _____ unlikely
extremely quite slightly neither slightly quite extremely

11. My use of the activities and investigations with the students I teach next year will clarify for students the physical science concepts and principles they study.

likely _____ : _____ : _____ : _____ : _____ : _____ : _____ unlikely
extremely quite slightly neither slightly quite extremely

12. My use of the activities and investigations with the students I teach next year will provide opportunities for students to interact with one another and the teacher.

likely _____ : _____ : _____ : _____ : _____ : _____ : _____ unlikely
extremely quite slightly neither slightly quite extremely

13. My use of the activities and investigations with the students I teach next year will make physical science more interesting and fun.

likely _____ : _____ : _____ : _____ : _____ : _____ : _____ unlikely
extremely quite slightly neither slightly quite extremely

Now we would like to know how you think other people feel about your use of the activities and investigations with the students you teach next school year.

(Continued on next page)

Subjective norm

Most people who are important to me think
I should _____ : _____ : _____ : _____ : _____ : _____ : _____ I should not use the activities and investigations with the students I teach next year.

Normative beliefs

1. My superintendent thinks
I should _____ : _____ : _____ : _____ : _____ : _____ : _____ I should not use the activities and investigations with the students I teach next year.

2. Parents think
I should _____ : _____ : _____ : _____ : _____ : _____ : _____ I should not use the activities and investigations with the students I teach next year.

3. My principal and other school administrators think
I should _____ : _____ : _____ : _____ : _____ : _____ : _____ I should not use the activities and investigations with the students I teach next year.

4. Students think
I should _____ : _____ : _____ : _____ : _____ : _____ : _____ I should not use the activities and investigations with the students I teach next year.

5. Other science teachers think
I should _____ : _____ : _____ : _____ : _____ : _____ : _____ I should not use the activities and investigations with the students I teach next year.

6. My department chairperson (team leader) thinks
I should _____ : _____ : _____ : _____ : _____ : _____ : _____ I should not use the activities and investigations with the students I teach next year.

Motivation to comply

1. Generally speaking, how much do you want to do what your superintendent thinks you should do?
Very much _____ : _____ : _____ : _____ : _____ : _____ : _____ Not at all

2. Generally speaking, how much do you want to do what parents think you should do?
Very much _____ : _____ : _____ : _____ : _____ : _____ : _____ Not at all

3. Generally speaking, how much do you want to do what your principal and other school administrators think you should do?
Very much _____ : _____ : _____ : _____ : _____ : _____ : _____ Not at all

4. Generally speaking, how much do you want to do what students think you should do?
Very much _____ : _____ : _____ : _____ : _____ : _____ : _____ Not at all

5. Generally speaking, how much do you want to do what other science teachers think you should do?
Very much _____ : _____ : _____ : _____ : _____ : _____ : _____ Not at all

(Continued on next page)

6. Generally speaking, how much do you want to do what your department chairperson (team leader) thinks you should do?
Very much _____ : _____ : _____ : _____ : _____ : _____ : _____ Not at all

Now we would like to know about the factors that might help or prevent your use of the activities and investigations with the students you teach next school year.

Perceived behavioral control

1. It is mostly up to me whether I use the activities and investigations with the students I teach next school year.
True _____ : _____ : _____ : _____ : _____ : _____ : _____ False

2. The supply and accessibility of materials and equipment needed for me to use the activities and investigations with the students I teach next year can best be described as
adequate _____ : _____ : _____ : _____ : _____ : _____ : _____ inadequate

3. Too much class time is needed for me to use the activities and investigations with the students I teach next school year.
Agree _____ : _____ : _____ : _____ : _____ : _____ : _____ Disagree

4. There is very little I can do to make sure I use the activities and investigations with the students I teach next school year.
Agree _____ : _____ : _____ : _____ : _____ : _____ : _____ Disagree

5. My class(es) will be too large for me to use the activities and investigations with the students I teach next school year.
likely _____ : _____ : _____ : _____ : _____ : _____ : _____ unlikely

6. I lack enough planning and preparation time to use the activities and investigations with the students I teach next school year.
Agree _____ : _____ : _____ : _____ : _____ : _____ : _____ Disagree

7. Compare the curriculum you teach with the curriculum you will be teaching if you use the activities and investigations with the students you teach next school year. How often would the goals, objectives, and essential elements of both be similar?
frequently _____ : _____ : _____ : _____ : _____ : _____ : _____ never

8. If I wanted to I could use the activities and investigations with the students I teach next school year.
likely _____ : _____ : _____ : _____ : _____ : _____ : _____ unlikely

9. I have the knowledge needed to use the activities and investigations with the students I teach next school year.
likely _____ : _____ : _____ : _____ : _____ : _____ : _____ unlikely

10. The classroom I teach in has the facilities I need to use the activities and investigations with the students I teach next school year.
likely _____ : _____ : _____ : _____ : _____ : _____ : _____ unlikely

(Continued on next page)

11. Students I teach lack the ability and interest for me to use the activities and investigations with the students I teach next school year.
Agree _____ : _____ : _____ : _____ : _____ : _____ : _____ Disagree

12. For me to use the activities and investigations with the students I teach next school year is
easy _____ : _____ : _____ : _____ : _____ : _____ : _____ difficulty

13. Of the activities and investigations available to me to use with the students I teach next school year I have actually tried
more _____ : _____ : _____ : _____ : _____ : _____ : _____ less
considerably> somewhat> slightly> exactly 50% slightly< somewhat< considerably<

14. The principal and other teachers support my use of the activities and investigations with the students I teach next school year.
likely _____ : _____ : _____ : _____ : _____ : _____ : _____ unlikely

15. How much control do you have over whether you use or do not use the activities and investigations with the students you teach next school year?
complete very little
control _____ : _____ : _____ : _____ : _____ : _____ : _____ control

Now we would like to know some basic information about you, your preparation, and teaching experience.

1. Indicate your sex. Male Female (Circle one) 2. How old are you? _____

3. Which of the following designations best describes the location of the school in which you will teach this year? (Check only one)
_____ Major urban (population ≥ 450,000)
_____ Central city (population 100,000 - 450,000)
_____ Independent town (population 25,000 - 100,000)
_____ Other
_____ Major suburban
_____ Central city suburban
_____ Rural

4. In what area(s) do you hold certification to teach? (Check as many as apply)
_____ Not certified
_____ Provisional (Lacking some requirements)
_____ Elementary education (Specify grades _____)
_____ Secondary Education (Science Composite)
_____ Secondary Education (Two single subject fields)
The two single subject fields are: _____ and _____
_____ Other (Please specify) _____

5. How many years have you been teaching? _____

6. How many years have you been teaching science? _____ physical science? _____

Thank you for your time, patience, and cooperation in completing this questionnaire. In the space below and on the back feel free to write any comments or suggestions you may have for improving the Institute in Physical Science.

Frank E. Crowley
Project Director

SUMMER INSTITUTE IN SCIENCE

Course/Instructor Evaluation

Course Title: _____

Directions: Below are listed several statements that could be used to describe your opinion about the course you are about to complete and your instructor in the course. Indicate the extent to which you agree with each statement using the following response scale:

SD - Strongly Disagree
D - Disagree
U - Uncertain
A - Agree
SA - Strongly Agree

		(Circle One)
1.	The instructor was well prepared for class.	SD D U A SA
2.	Class instruction was time well spent.	SD D U A SA
3.	The instructor made me feel free to ask questions and express my ideas.	SD D U A SA
4.	The instructor was intellectually stimulating.	SD D U A SA
5.	The instructor revealed enthusiasm for teaching the course.	SD D U A SA
6.	Activities and discussions clarified concepts for me.	SD D U A SA
7.	The instructor gave adequate instructions for activities, investigations, and assignments.	SD D U A SA
8.	Tests questions were clear.	SD D U A SA
9.	Test questions covered topics included in the course.	SD D U A SA
10.	The texts and references used in the course were appropriate.	SD D U A SA
11.	Class activities were appropriate to my needs.	SD D U A SA
12.	The instructor was interested in making me a better teacher of physical science.	SD D U A SA
13.	I learned much information applicable to teaching physical science.	SD D U A SA
14.	I will probably be satisfied with my grade in this course.	SD D U A SA
15.	I found this course to be interesting.	SD D U A SA
16.	I enjoyed attending class.	SD D U A SA
17.	I will recommend this course to other teachers interested in enrolling in a physical science course.	SD D U A SA
18.	I will use the information covered in this course when I teach.	SD D U A SA
19.	This course has increased my interest in teaching physical science.	SD D U A SA
20.	The pace of the course was about right.	SD D U A SA
21.	The number of topics covered was sufficient.	SD D U A SA

22. Name three lessons (topics) that you consider to have been the best and three that you consider to be most in need of improvement.

Best: _____ Worst: _____

_____ _____

_____ _____

23. Are there topics (concepts) that were not included in the course that you think should have been included? If so, list the topics (concepts).

1. _____ 3. _____
2. _____ 4. _____

If you have additional comments that you would like to make about this course, write them on the back of this page.

Institute in Physical Science

Program Evaluation

Please mark with an "x" in the space provided the course(s) in which you were enrolled.

- ☐ Concepts in Chemistry
- ☐ Concepts in Physics
- ☐ Concepts in Physical Science
- ☐ Frontiers in Physical Science

Directions: Below are listed several statements that could be used to describe your opinion about the Institute in Physical Science Program. Indicate the extent to which you agree with each statement using the following response scale:

SD - Strongly Disgree
D - Disagree
U - Uncertain
A - Agree
SA - Strongly Agree

(Circle one)

1. Before attending the Institute in Physical Science, I was worried about going back to school. SD D U A SA
2. I was uneasy about attending a summer program held at UT-Austin. SD D U A SA
3. The Welcoming Banquet helped to clarify Institute expectations, procedures, and requirements. SD D U A SA
4. Five weeks is an appropriate length of time for the Institute. SD D U A SA
5. The length of time for each class meeting was acceptable.
   - Three hours per meeting for chemistry/physics/physical science. SD D U A SA
   - Five and a half hours per class meeting for Frontiers in Physical Science. SD D U A SA
6. The resource guides will be useful for teaching physical science. SD D U A SA
7. The textbooks and materials used in each course were well chosen. SD D U A SA
8. Teacher-conducted workshops are an effective means for spreading the word to other teachers about Institute activities/investigations. SD D U A SA
9. I intend to use the course materials, activities, and investigations when teaching physical science. SD D U A SA
10. The Institute in Physical Science Program was well organized. SD D U A SA
11. Members of the Institute staff were helpful. SD D U A SA
12. The Institute in Physical Science accomplished its goals:
    - to improve secondary teachers' understanding of fundamental concepts in physics and chemistry, SD D U A SA
    - to improve fifth and sixth grade teachers' understanding of physical science and provide them with training in the use of physical science activities and investigations and the Essential Elements to teach physical science in grades five and six, SD D U A SA
    - to provide high school physical science teachers with training in the use of activities and investigations stressing the development of the Essential Elements when teaching introductory physics and chemistry concepts included in the physical science course, and SD D U A SA
    - to update teachers' knowledge of research ii science education related to the teaching and learning of science and of research and development activities in physics, chemistry, and technology taking place within the Austin metropolitan community. SD D U A SA

(continued on next page)

13. Overall, the Institute in Physical Science was a success. SD D U A SA
14. I will encourage teachers to apply for future Institute in Physical Science programs. SD D U A SA
15. I would like my name added to the mailing list to be considered for future teacher training programs held at the Science Education Center. SD D U A SA

Name: _____
Address: _____
City, State: _____ Zip Code: _____
Telephone: (__ __ __) __ __ __-__ __ __ __

In the space below feel free to offer any additional comments and suggestions that you think might be helpful in planning future Institute in Physical Science programs.